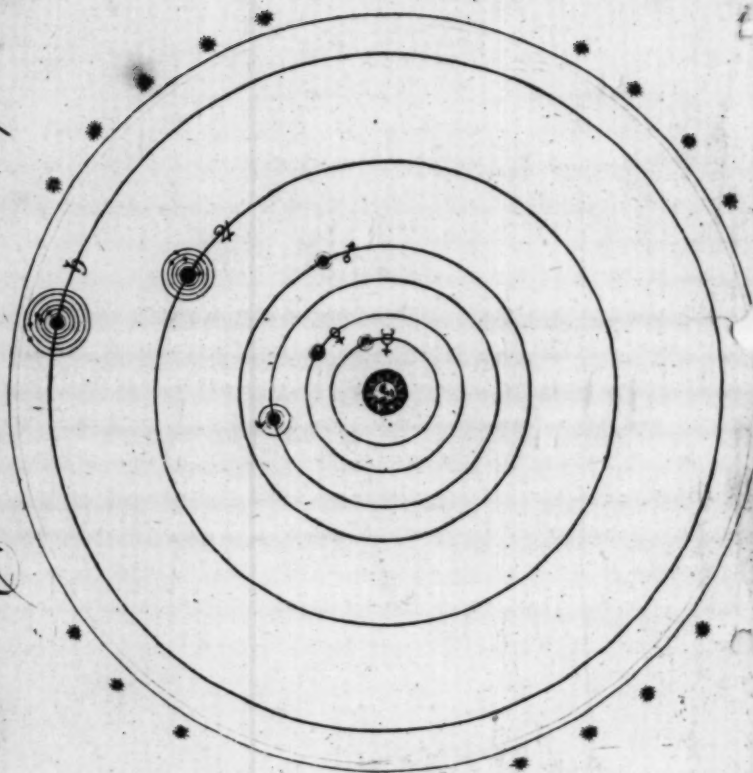
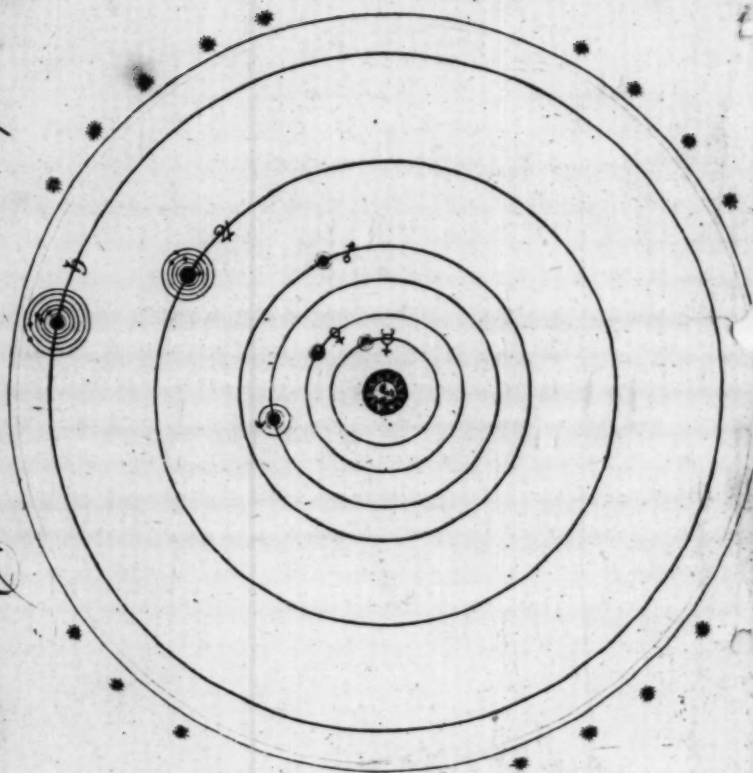


The true Copernican or solar system.



The true Copernican or solar system.



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SUCCINCT TREATISE

OF

Popular Astronomy:

OR,

THAT SCIENCE MADE PLAIN, EASY,
AND INTELLIGIBLE TO EVERY
CAPACITY.

TO WHICH ARE SUBJOINED,

PROGNOSTICS OF THE WEATHER,

From the SUN, MOON, STARS, CLOUDS, METEORS, &c.

By a LOVER of the SCIENCES.

*Os homini sublime dedit : coelumque tueri
Jussit, et erectos ad sidera tollere vultus. OVID;*

EDINBURGH;

PRINTED FOR THE AUTHOR.

[PRICE ONE SHILLING.]



C O N T E N T S.

<i>Of The Ptolemaic System refuted,</i>	5
— <i>The Tychonian System refuted,</i>	7
— <i>The Pythagorian, or Copernican System ; or true System of the Universe,</i>	8
— <i>The Sun,</i>	11
— <i>The Planets ; and, first, of Mercury,</i>	13
— <i>Venus and her Phases,</i>	<i>ib.</i>
— <i>The Earth and its Satellite,</i>	14
— <i>The Earth's Atmosphere,</i>	16
— <i>The Moon,</i>	17
— <i>Mars,</i>	19
— <i>Jupiter and his four Satellites,</i>	20
— <i>Saturn, his five Satellites, and wonder- ful Ring,</i>	21
— <i>Comets,</i>	22
— <i>The fixed Stars,</i>	24
— <i>Physical Causes of the Planets motions,</i>	25
— <i>Proportion of the Earth to the Sun and Planets,</i>	28
— <i>Eclipses,</i>	32
— <i>Prognostics of the Weather,</i>	33

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ASTRONOMICAL DICTATES.

T H E

PTOLOMEAN SYSTEM REFUTED.

THIS system supposes the Earth quiescent in the centre of the universe, and all the planets, with the Sun and fixed Stars, to move round it in 24 hours: Here the simplicity of the system and analogy of motions are neglected, nor is there any astronomical or physical argument for a foundation of such a hypothesis; according to which, Mercury and Venus can never be behind the Sun, as their orbits are included within the Sun's orbit; whereas the contrary is evident, as they are just as often observed behind the Sun as before it. These two planets appear by the telescope in all the various shapes of the Moon, a sure argument that they shine not by their own light, and their regular phases shew them to be spherical bodies..

Because the Earth's orbit is included within the orbits of Mars, Jupiter, and Saturn, they are seen on all sides of the Heavens, and

are as often in opposition to the Sun, as in conjunction with him; whereas, if the Earth stood still, they would always appear direct in their motion, and never retrograde or stationary; and this sufficiently proves the Earth's annual motion.

There is no such thing in nature, as a great body moving round a smaller, as may be observed from the satellites of Jupiter and Saturn, as also the Moon, all of these moving round their primary planets.

Should the Sun and fixed Stars go round the Earth each 24 hours, such a motion would be incomparably quicker, than if all the water in our rivers, seas, and oceans, should run through the hollow of a swan's quill in the space of one minute only.

If the Sun were to move round the Earth in 24 hours, he must travel at the rate of 21,213,720 miles each hour*, which is more than a cannon ball would go in five years; yet would be no more in proportion to the fixed Stars, than one is to 10,210, which swift motions, (being as improbable as incomprehensible) were they real, could answer no other ends than are gained by the Earth's turning round its axis every 24 hours from west to east, causing an apparent diurnal motion of the Sun from east to west, and its going round the Sun once a year, which causes him to have an apparent annual motion round the starry Heavens, and the Stars to gain so much on the Sun

* The course of a common bullet is 480 miles each hour.

Sun each day, as to make 366 apparent revolutions in 365 days.

Philosophers (in time) rejected this rude scheme, as a medley of the grossest errors and absurdities, fit only for the blind and zealous bigot.

As to the objections taken from scripture expressions, it is plain, from many instances, that the scriptures were never intended to instruct us in Philosophy and Astronomy; nor is there any thing in them to be understood as strictly asserted in relation thereto, but only expressed agreeable to the common apprehensions of mankind.

We all know, that the Moon appears as big as the Sun; for which reason Moses calls them *two great lights*; whereas, we now know the Sun to be near 40,000,000 of times as big as the Moon; and the Moon is so far from being a *luminous* body, that she shines only by the reflected or borrowed light of the Sun.

The TYCHONIAN SYSTEM refuted.

THIS system succeeded the Ptolomean, in which the Earth also was supposed quiescent in the center of the universe, and the Sun and fixed Stars to revolve about it in 24 hours, and the Planets, at same time, to go round the Sun. This hypothesis being partly true, and partly false, was embraced by few, and soon gave way to the only true one; or,

The

The COPERNICAN SYSTEM of the Universe.

THIS System was taught by the wise Samian, Pythagoras, and others among the ancients ; but, in later times, was lost, till the fifteenth century, when it was again revived, by that famous Polish philosopher Nicolaus Copernicus, born in the year 1473. He is followed by the greatest philosophers and mathematicians who have lived since ; the last of whom, Sir Isaac Newton, has established it on such a foundation of mathematical and physical demonstration, that none can hesitate about it who understands him.

Here we must allow, that, as space can be terminated by no bounds, doubtless the Supreme Almighty Intelligence has every where manifested the same wisdom which he has shown to the inhabitants of the earth, in this small compass, which, though immensely above our comprehension, is but small, when compared with infinite space.

The Earth, with sixteen other bodies, is all we know of, and is what we call the *Planetary System*. These all move in a determinate space ; neither do they recede from, or come nearer to one another, beyond their set bounds : And their motions are performed according to unchangeable laws.

The whole art of Astronomy is almost employed about these. The other bodies that constitute the universe are at a distance so immense,

menſe, that their motions cannot fall under our obſervation. Of theſe only the remarkable ones are perceived by us ; and moſt of ſuch as are viewed by the teleſcope are inviſible to the naked eye.

To aſſiſt the imagination in conceiving an idea of the vaſt diſtance of the Sun, Planets, and Stars, let us ſuppoſe a body projected from the Sun to fly with the ſwiftness of a cannon-bullet, it would but reach the earth in 19 years and 31 days ; Saturn, in 184 years, and 240 days ; the Comet of 1680, in its aphelion, in 2660 years ; and, to the neareſt of the fixed Stars, in about 7,000,600 years.

By the teleſcope, we diſcover thouſands of ſtars, which are inviſible to the unaffiſted eye ; and the better our teleſcopes are, ſtill the more become viſible : So that we can ſet no limits either to their number or diſtances. The famous Huygens carries his thoughts ſo far as to believe there may be ſtars at ſuch inconceivable diſtances, that their light may not yet have reached the earth ſince its creation, notwithſtanding the amazing velocity of light, which flies a million of times ſwifter than a cannon bullet ; a ſuppoſition far from being extravagant.

By the teleſcope, we alſo know, that the *Milky Way* hath its complexion from an infinite number of ſtars or ſuns in thoſe parts of the expanſe that go by that name ; ſo that, in place of one Sun, and one World only, Astronomy diſcovers to us ſuch an inconceivable number

number of Suns, Worlds, and Systems, dispersed through boundless space, that if our Sun, with all the Planets, Moons, and Comets belonging to it, were annihilated, they would no more be missed out of the creation than a grain of sand from the sea shore; the space they occupy being comparatively so small, that it scarce would be a sensible blank in the Universe.

Although Saturn, the outermost of our planets, revolves about the Sun in an orbit of 4884,000,000 of miles in circumference, and some of our comets make excursions upwards of 10,000,000,000 miles beyond Saturn's orbit; yet, at that amazing distance, they are incomparably nearer the Sun than to any of the fixed stars, as is evident from their keeping clear of their attractions, and returning periodically, by virtue of the Sun's attractive power: and, therefore, from what we know of our own system, it may be reasonably concluded, that all the rest are, with equal wisdom, contrived, situated, and provided with accommodations for rational inhabitants. For, tho' there is almost an infinite variety in all the parts of the creation which we have the opportunity of examining, yet there is a general analogy running through the whole; from all which the hypothesis of a plurality of worlds is rational, worthy a philosopher, and greatly redounds to the glory of the Great Creator.

We, therefore, conceive an indefinite mundane space, consisting of an indefinite number of systems, and, in the middle of each one of them,

them, a Sun rolling round his axis, and carrying about with him satellites or planets; and our Sun, being in the middle of our system, and not being at an immense (though a very great) distance from us, appears to us of a considerable magnitude; but the rest of the Suns, being at almost an infinite distance from us, appear to us as lucid spots, though, were we as near to any of them as we are to our Sun, it is probable, they would shew of equal magnitude and splendor with that glorious body.

As the Earth, with sixteen other bodies, constitute the *Solar System*; so those planets, which are nearest the Sun, finish their course sooner, and move quicker, in their respective orbits, than those which are more remote from him: Their motions are all performed from west to east, in orbits nearly circular; and their names, distances, bulks, and periodical revolutions, are as follow;

The SUN

Is an immense globe of fire, placed near the common centre, or rather, in the lower focus of the orbits of all the planets and comets, and turns round his axis in 25 days 6 hours: His circumference is computed to be 2,338,000 miles; and, by the various attractions of the circumvolving planets, is agitated by a small motion round the centre of the sphere.

The

The Sun appearing under a larger angle in winter than in summer, proves the Earth to be nearer the Sun at that time: And the cause why we have not in that season the hottest weather, is, that his rays fall then so obliquely on us, that any given number of them is spread over a much greater portion of the Earth's surface where we live; and, therefore, each point must then have fewer rays than in summer, though the Earth is in winter nearer to the Sun by 2,754,000 miles.

As light is not instantaneous, though its velocity is a million of times swifter than a cannon-bullet; so, in travelling from the Sun across the Earth's orbit, (which is 162 millions of miles in length), it must be eight minutes in coming to us: Hence, if the Sun were annihilated, we should see him eight minutes after; and if he were again created, he would be so old ere we could see him.

The velocity of light is 164,000 miles each second; and its particles, so amazingly small, flowing from the Sun in different bodies, are thereby reflected to our eyes, exciting in us the idea of that body, by forming its picture on our retina; and, since bodies are visible on all sides, light must be reflected from them in all directions.

By the atmosphere's refraction, the Sun is apparent, ere he rises in the horizon, and after he is wholly set; some times of the year, about ten minutes; and, at a mean rate, every day, about six.

M E R.

MERCURY

Is the nearest planet to the Sun ; and goes round him in 87 days 23 hours, which is the length of his year.

As no spots have yet been seen (by the telescope) on his disk, the time of his rotation on his axis, or the length of his day and night, is as yet unknown.

His distance from the Sun is 32 millions of miles, and his circumference is 13,350.

His course round the Sun is 96,332 miles each hour ; and his light and heat from the Sun is seven times as great as ours : To him the Sun appears seven times as big as to us. This planet appears, by the telescope, to have all the various shapes of the Moon, save only never quite full ; because his enlightened side is turned to us only when he is so near the Sun as to be lost in his beams.

VENUS,

THE next planet in order, is 59 millions of miles from the Sun ; and, by moving at the rate of 68,766 miles every hour, goes round the Sun in 244 days and 17 hours, which is the length of her year. Her circumference is 24,820 miles, and her diurnal rotation about her equator, 48 miles each hour.

She has only $9\frac{1}{4}$ days in her year ; so that
 B every

every day and night with her, is as long as $24\frac{1}{4}$ days and nights with us; and this odd quarter of a day, makes every fourth year to be a leap year, as the like does to us.

By the telescope, this planet also appears to have all the various phases of the Moon.

The E A R T H

Is the next planet above Venus, is 81 millions of miles from the Sun, and goes round him in 365 days, 5 hours, and 49 minutes, from any equinox or solstice to the same again; but from any fixed star to the same again, as seen from the Sun, in 365 days, 6 hours, and 9 minutes; the former being the length of the *tropical year*, and the other the length of the *sidereal year*, at the rate of 58,080 miles each hour, being 120 times swifter than a cannon bullet. Its circumference is 25,000 miles, and it turns round its axis in 24 hours from west to east; by which rapid motion, the inhabitants at the equator are carried 1042 miles each hour.

The Earth contains 199,512 595 square miles on its surface, viz. The seas and unknown parts, 160,522,026. The inhabited part, 38,990,596. Europe, 4,456,065. Asia, 10,768,823. Africa, 9,654,807. America, 14,110,874. Of which it is computed, that nearly three-fourths of the surface, between the polar circles, are covered with water, and only little more than one-fourth is dry land.

As

As the earth is not the centre of the planets orbits, they come nearer to, and recede from it at different times; on which account they appear bigger, and less, by turns. Mercury appears $5\frac{1}{2}$ times as big at his least distance, as at his greatest. Venus, 22 times. Mars, 25. Jupiter, a little more than twice. Saturn, $\frac{1}{2}$. Hence, the apparent bulks of the planets in the heavens, are not always a certain rule to know them by.

That the Earth is round like a globe, is plain in eclipses of the Moon, from the ship's hull being hid by the convexity of the water, while the masts are visible; and, lastly, from its being sailed round by navigators. As for the hills, they take no more from its roundness, than the atoms of dust on a common ball.

Of this figure, we presume, are all the planets; but their figure is not perfectly spherical, being a little changed by their motion round their axis; and though this cannot be observed in most of them, yet may it be deduced from observations made upon Jupiter and the Earth. Astronomers have observed, that the axis of Jupiter is shorter than its equatorial diameter.

By the *axis* of the Earth, or other planet, we mean, that physical line which passes through the centre, terminating in the opposite points of its surface; such a line, a bowl thrown in the open air, turns round, whilst it moves foreward.

Of the EARTH'S ATMOSPHERE.

THE Atmosphere is an elastic fluid, gravitating towards the Earth, revolving with it in its diurnal motion, and going along with it in its annual course round the Sun; the lowermost parts of, which being pressed by the uppermost, are densest at the Earth's surface, and gradually rarer the higher up, as is evident from the barometer. Thus,

If, at the foot of a mountain, most of the air be pressed out of a bladder, its neck tied so fast that no more can enter; if it be then carried to the top of the mountain, the few particles of air left will expand themselves, so as to fill the bladder more and more all the way going up; which demonstrates the springy quality of that fluid; as also, that the circumambient air grows lighter the higher we ascend.

If the barometer be carried along, the height of the mountain will be thus ascertained: The mercury in the tube will descend $\frac{1}{2}$ of an inch each 30 yards, according to Doctor Halley; but, according to Dr Derham, somewhat less.

To the Atmosphere we owe the bright appearance of the heavens in the day time; without it, that part of the heavens only would shew, in which the Sun was placed.

From

From experiments made with the air pump, the Atmosphere's pressure is equal to 14 pound weight on every square inch of all terrestrial bodies; so that a middle-sized man, whose surface is about 14 square feet, is pressed by 28,224 pound weight of air all around; but because this enormous weight is equal all around, and counterbalanced by the internal air in our blood vessels, it is not felt.

When, through the state of the air, we feel ourselves dull or languid, it is then imputed to the air's being foggy or heavy about us; but the true cause is, that the air being then too light, and insufficient to counterbalance the air within us, our fibres are relaxed, and lose part of their elasticity.

The height of the Atmosphere (so far as it is dense enough to reflect any light) is 44 miles, but it is seldom dense enough to bear up the clouds at more than two miles distance.

N. B. The standard mile here (and all along) is the English mile, whose measure is 1760 yards, or 5280 feet, or 1200 geometrical paces, being five feet each, the common pace being only two one-half feet.

The Moon

Is an opaque globe, and shines by reflecting the Sun's light; therefore, whilst that half of her which is towards the sun is enlightened, the other half must be dark and invisible. Hence

she disappears when she comes between us and the Sun, because her dark side is then towards us. Gradually, as she goes forward, we see a little more of her enlightened side, which still encreases to our view, till she become opposite to the Sun. Then her whole enlightened side is towards the Earth, which we call *full Moon*; from which she decreases, by degrees, through the other half of her course, shewing us every day less of her enlightened side, till her next change or conjunction with the Sun, when she again disappears. The Moon, as a satellite to the Earth, moves round the same in 29 days 12 hours and 44 minutes, and goes with it once every year round the Sun.

Her circumference is 6850 miles. She goes round her orbit in 27 days, seven hours and 43 minutes, moving about 2290 miles each hour; and turns round her axis exactly in the same time she goes round the Earth, which is the reason of her always keeping the same side towards us; her night and day, taken together, being just as long as our Lunar month.

The Moon is 50 times less than the earth, is full of high mountains, large valleys, and deep caverns: And from the Moon's attraction we only account for tides.

It is found there are disturbances among the planets motions, from their mutual attractions, when in the same quarter of the heavens, and that our years are not always of the same length precisely. Hence there is reason to believe, that the Moon is somewhat nearer,
the

the Earth now than formerly, her periodical motion being shorter than it was in former ages ; for our astronomical tables, which, in the present age, shew the times of solar and lunar eclipses to great perfection, do not so well answer for ancient eclipses. Hence the Moon appears not to move in a medium void of all resistance ; so that her projectile force being somewhat weakened, while there is nothing to diminish her gravity, she must at last fall to the Earth ; unless that Being, which gave a sufficient projectile force at first, add to it in due time.

As the Moon has no atmosphere to exhale the vapours, she can have no rains or storms ; and her inhabitants must live without the use of speech or hearing, as there can be no sounds where there is no air : and as there is no atmosphere, a Lunarian, who turns his back to the Sun, will have the appearance of the heavens as in the night time, the brightness of which (with us) being wholly owing to our atmosphere.

What is singular in the Moon ; one half of her has no darkness at all, the Earth constantly affording light in the Sun's absence, while the other half has a fortnight's darkness, and a fortnight's light by turns.

M A R S

Is the first planet above the Earth's orbit ; his distance from the Sun is 123 millions of miles ; and moving at the rate of 46,762 miles each

each hour, he goes round the Sun in 687 days, 17 hours, which is the length of his year, and contains $667\frac{1}{4}$ of his days, which are 40 minutes longer than with us.

His circumference is about 13,290 miles; and, by his diurnal rotation, the inhabitants at his equator are carried 556 miles each hour: his quantity of heat and light is equal to one-half of ours; and the Sun appears to him but half as big as to us. This planet is but one-fourth as big as our Earth; and, by the telescope, appears sometimes gibbous, but never horned; is of a fiery red colour, and seems surrounded by a very gross atmosphere. If there be any Moon attending him, it must be very small, as our best telescopes have not yet made the discovery.

J U P I T E R,

THE largest of all the planets, is still higher in the system, being about 424 millions of miles from the Sun, and going at the rate 25,542 miles each hour in his orbit, finishes his annual period in 11 years, 313 days, and 15 hours.

He is above 1000 times as big as our Earth; for his circumference is 254,748 miles, which is more than 10 times the circumference of the Earth.

He turns round his axis in 9 hours 56 minutes; by which prodigious quick rotation,
his

His equatorial inhabitants are carried 25,920 miles each hour.

He is surrounded by belts, or zones, which are subject to great apparent mutations.

To him the Sun appears but $\frac{1}{11}$ part so big as to us; and his heat and light are in the same proportion, but compensated by the quick returns thereof, and by 4 Moons, some of which are bigger than our Earth. These are visible with an ordinary telescope, and revolve about him in orbits nearly circular; the first, or innermost, at 130,000 miles distance, in 1 day 18 $\frac{1}{2}$ hours; the next, at 364,000 miles distance, in 3 days 13 $\frac{1}{4}$ hours; the third, at 580,000 miles distance, in 7 days 3 $\frac{2}{3}$ hours; the outmost, at 1,000,000 miles distance, in 16 days 1 $\frac{1}{5}$ hours.

SATURN,

THE outmost of all the planets, is about 777 millions of miles from the Sun, going at the rate of 18,910 miles each hour: He performs his annual circuit in 29 years, 167 days, and 10 hours: His circumference is 191,700 miles, which is 600 times as big as our Earth: He is surrounded by a thin broad ring, which appears double by a good telescope; this ring is 21,000 miles in breadth, which is equal to its distance from Saturn on all sides.

Saturn having no visible spots on his body,
the

the length of his day and night is to us unknown.

To Saturn the Sun appears only $\frac{1}{86}$ so big as to us, and his light and heat from the Sun in like proportion; to compensate which, he has five Moons, all going round him on the outside of the ring: The first, or nearest, in 1 day 21 hours and 19 minutes, and at 140,000 miles distance from his centre.

The second, in 2 days 17 hours and 40 minutes, at the distance of 187,000 miles.

The third, in 4 days 12 hours and 25 minutes, at the distance of 263,000 miles.

The fourth, in 15 days 22 hours and 41 minutes, at the distance of 600,000 miles.

The fifth, or outmost, in 79 days 7 hours and 48 minutes, at the distance of 1,800,000 miles.

Of COMETS.

COMETS are solid opaque bodies, with long transparent trains, issuing from that side turned from the Sun, and moving round him in very eccentric orbits, and are of a much greater density than the Earth; for some of them are heated in every period to such a degree, as would vitrify or dissipate any substance known to us.

The heat of that in 1680, in its *perihelion*, or nearest approach, was computed by Sir Isaac Newton to be 2000 times hotter than red hot iron; and, being thus heated, must retain its heat

heat for the space of 577 years. It is believed, that 21 (at least) belong to our system, moving in all directions; of all which, only the periods of three are known with any degree of certainty. The first appeared in the years 1531, 1607, and 1682; and was expected again in 1758*, and every 57th year afterwards. The second appeared in 1532, and in 1661; and may be expected in 1783, and every 129th year afterwards. The third appeared in 1680; its period, being 575 years, cannot return till 2225. This Comet, at its greatest distance, or *aphelion*, is at least 11,200,000,000 miles from the Sun; and, in that part of its orbit which is nearest the Sun, flies with the amazing swiftness of 880,000 miles each hour. The astonishing length this Comet runs out in empty space, suggests to us an idea of the vast distance between the Sun and the nearest fixed Stars, of whose attractions all the Comets must keep clear, to return periodically round the Sun; and shews us, that the nearest fixed Stars are, probably, those that shew the largest, and are of like nature and bigness with our Sun, otherwise they never would appear so large and bright to us, at so great a distance.

The extreme heat, the dense atmosphere, the gross vapours, and chaotic state of the Comets, seem to indicate them most miserable

* A Comet did actually appear in 1758, but not in the same direction.

habitations for rational beings; and, therefore, by some, thought to be intended for bringing Divine vengeance on the inhabitants of such planets (by deluges and conflagrations) as pass through their atmosphere, in their descent to, or ascent from the Sun; whilst, by others, they are conceived to be so many hells, to punish the damned with perpetual vicissitudes of heat and cold: But if, on the other hand, we consider the infinite power and goodness of the Deity, the first enabling him, and the latter inclining him, to make creatures suited to all states and circumstances, and that matter exists only for the sake of intelligences, we may be allowed to make a very opposite conjecture.

Of the FIXED STARS.

THE fixed Stars being at a distance so immense from the Sun, cannot possibly receive from him brightness sufficient to make them at all visible to us, by reason the Sun's rays would be so dissipated ere they reached such remote objects, that they never could be transmitted back to our sight by reflection: And, therefore, they shine with their own native and unborrowed lustre, as the Sun does; and, being, one with another, as big as he, and each confined, like him, to one portion of space, it is plain they are of the same nature with him; Nor is it at all probable, that the
Almighty,

Almighty, who always acts with infinite wisdom, and does nothing in vain, should create so many glorious Suns, fit for so many important purposes, and place them at such immense distances, without proper objects to be benefited by them; and it is certain, whoever thinks they were created only to give a faint glimmering light to the inhabitants of this globe, must have but a superficial knowledge of Astronomy, and an equally mean opinion of the Divine Wisdom, since, by an infinitely less exertion of creating power, God could have given us much more light by one single additional Moon. It is, therefore, reasonable to suppose, that they serve the noble purposes of light and heat for the planets of their several systems.

The Earth, in going round the Sun, is 162,000,000 miles nearer to some of the fixed Stars at one time of the year than at another; yet their apparent magnitudes, situations, and distances from one another, still remain the same; and a telescope which magnifies above 200 times, does not sensibly magnify them, which proves them to be 400,000 times farther from us, than we are from the Sun.

The PHYSICAL CAUSES *of the* PLANETS MOTIONS.

FROM the uniform projectile motion of bodies in straight lines, and the universal power
C of

of attraction, arises the curvilinear motion of all the heavenly bodies : for, if a body be projected in open space, where it meets with no resistance, nor is attracted by any other power, it will go on, for ever, in the same direction ; and, the stronger one body attracts another, the greater must be the projectile force, and, consequently, the quicker must be the motion of that other body to keep it from falling on its primary or central planet.

The quick motions of the Moons of Jupiter and Saturn round their primaries, demonstrate these planets to have stronger attractive powers than the Earth : for Jupiter's second Moon is 124,000 times farther from him than our Moon is from us ; and yet this second Moon goes more than eight times round him, whilst our Moon goes round the Earth once ; which shews what prodigious attractive power the Sun must have, to draw the whole system towards him.

As the stronger any circulating body is attracted by a central one, the greater must the projectile force impressed upon the former be, to keep it from falling on the latter ; so we find, that if one planet be twice as far from the Sun, or one satellite be twice as far from its primary planet as another, the remotest is attracted only by one-fourth of the force that acts on the nearest. By this we know how heavy any body would be upon the Sun, and on those planets which have Moons going round them.

A body which weighs only one pound on the Earth, would be half as heavy again on Saturn, twice as heavy on Jupiter, and 24 times as heavy on the Sun.

Matter, being of itself unactive, can never put itself in motion ; and, if once in motion, can never of itself stop. A ball discharged from a cannon would go on for ever, in a straight line, if the air did not resist its motion, and gravity bring it down to the Earth. Were there no air, and the ball were projected in a horizontal direction, and with a force equal to the power of gravity, or the Earth's attraction on the ball, it would, if not hindered by interposing obstacles, go round the Earth, and at its return strike on the breech of the cannon.

That there is such a power as gravity in the Earth, drawing all bodies on or near its surface towards its centre, is evident, from the descent of bodies, in right lines, perpendicular to its surface. There is no such thing in nature as a great body moving round a smaller ; and we find by observation, the attractive power or gravity is in proportion to the quantity of matter in the primary planet.

That the projectile force was given by the Deity, is evident ; as matter can never give itself motion, and all bodies may be moved in any one direction ; yet all the Planets, both primary and secondary, move from east to west, in planes nearly coincident ; whilst the Comets move in all directions, and in planes so different from one another, that their motions

can be owing to no other cause, than the power and choice of an intelligent Being.

Proportion of the EARTH to the SUN and PLANETS.

THE Earth is seven times as big as Mercury; very little bigger than Venus; four times as big as Mars. But Jupiter is 1064 times as big as the Earth; Saturn 601 times, exclusive of the ring; the Sun 878,000 times: But the Moon is 50 times less than the Earth; and is distant from the Earth 240,000 miles.

See the following TABLES.

Tables of the Magnitudes, Revolutions, Periods, &c. of the Planets.

Circumference in Miles.

Sun,	-	-	2,398,000
Mercury,	-	-	13,350
Venus,	-	-	24,820
Earth,	-	-	25,020
Moon,	-	-	6,850
Mars,	-	-	13,960
Jupiter,	-	-	254,470
Saturn,	-	-	191,700

Miles

Miles in Surface and Solidity.

Superficial Miles.

Cubic Miles.

Sun,	1,829,674,000,000	232,672,323,884,000,000
Merc.	- 56,710,800	- 40,151,246,000
Venus,	- 169,226,920	- 258,627,080,000
Earth,	- 199,400,400	- 264,815,683,200
Moon,	- 14,898,750	- 5,408,246,250
Mars,	- 59,060,760	- 44,704,962,400
Jupiter,	20,612,070,000	278,262,945,000,000
Saturn,	11,693,700,000	118,889,847,900,000

Distance from the Sun in Miles, and Proportion of Bulk to the Earth.

Distance.

Proportion.

		Sun, 878,000	
Mercury	32,000,000		$\frac{1}{4}$
Venus,	59,000,000		$\frac{3}{4}$
Earth,	81,000,000		1
Moon,			$\frac{1}{8}$
Mars,	123,000,000		$\frac{1}{4}$
Jupiter,	424,000,000	1064	
Saturn,	777,000,000	601	

C 3

Proportion

Proportion of Light and Heat.

Weight of Folies on the Surfaces.

Sun,	4,500	24,400
Mercury,	$6\frac{1}{2}$	unknown.
Venus,	$1\frac{3}{4}$	unknown.
Earth,	1	1
Moon,	1 *	$\frac{342}{100}$
Mars,	$\frac{3}{7}$	unknown.
Jupiter,	$\frac{1}{28}$	2
Saturn,	$\frac{1}{90}$	$1\frac{1}{2}$

Annual Periods.

Diurnal Revolutions.

	Y.	D.	H.		D.	H.	M.
Sun turns round his axis in					25	6	0
Mercury,	0	87	23		unknown.		
Venus,	0	224	17		24	8	0
Earth,	1	0	0		1	0	0
Moon,	1	0	0		29	12	30
Mars,	1	322	17		0	24	40
Jupiter,	11	313	15		0	9	56
Saturn,	29	167	10		unknown.		

The mark * signifies more or less than the Earth's distance; for the New Moon is 1,240,000 nearer the Sun than the Earth is, and the Full Moon as much further from him.

Hourly

<i>Hourly Velocities in their Orbits.</i>		<i>Hourly Equatorial Motion.</i>
Sun,		3,818
Mercury,	92,322	unknown..
Venus,	68,776	43
Earth,	58,080	1,042
Moon,	2,290	$9\frac{1}{2}$
Mars,	46,762	556
Jupiter,	25,543	25,920
Saturn,	18,910	unknown..
English miles.		

If the Projectile Force of the Planets was stopped, they would fall to the Sun in

		D.	H.
Mercury,	- -	15	13
Venus,	- -	29	17
Earth,	- -	64	10
Moon,	- -	64	10
Mars,	- -	121	0
Jupiter,	- -	290	0
Saturn,	- -	767	0

And, lastly, The Moon would fall to the Earth in 4 days 21 hours, its distance being 240,000 miles only.

Of ECLIPSES.

THE *conjunction* or *apposition* of the Moon with the Sun, or, which is the same thing, when

when the light of the Sun is intercepted by the Moon, so that, in respect of any observer upon the Earth, the Sun is partly or wholly covered, the *Sun* is said to undergo an *Eclipse*; but, properly speaking, this is an *Eclipse of the Earth*, on whose surface the shadow, or penumbra, of the Moon falls.

In like manner, an obscuration of the Moon by the shadow of the Earth, is called an *Eclipse of the Moon*.

An *Eclipse of the Sun* can never happen except at the time of the new Moon, and (on the other hand) an *Eclipse of the Moon* can only happen at the time of full Moon.

Eclipses are either *total*, as when the shadow of the Moon falls upon the Earth; or *partial*, when the penumbra only reaches the Earth.

But if there be an Eclipse of the Moon when the Earth is in the *perihelion*, and the Moon in the *apogæum*, that is, at the greatest distance from the Earth, the shadow of the Moon does not reach the Earth, and the Moon does not cover the whole Sun; then the Eclipse is said to be *annular*. This is what happens when we consider an Eclipse in general; but as to particular places, it is said to be *total*, in those places where the shadow passes; *central*, in those where the centre of the shadow passes, that is, where the centre of the Moon covers the Sun's centre; and, lastly, *partial*, where the penumbra only goes by, as in this figure,



PROGNOSTICS of *Wind, Rain, Hail, Thunder, Cold, Heat, Frost, Snow, &c.* from the *flights and appearances of Birds, Beasts, Insects, Plants, Stones, Clouds, Meteors, Sun, Moon, Stars, &c.*

IN Consequence of observation, that such creatures as live in the open air have a quick sensation of what changes are about to happen in that region, the following rules have been laid down by various naturalists who have applied themselves to signs of good or bad weather.

SIGNS of RAIN from BIRDS.

Sea and fresh water fowls, such as Cormorants, Sea-gulls, Muir-hens, &c. flying from sea, or the fresh waters, to land, shew bad weather at hand.

Land-fowls flying to waters, and those shaking, washing, and noisy, especially in the evening, denote the same.

Geese, Ducks, Coots, &c. picking, shaking, washing, and noisy.

Rooks and Crows in flocks, and suddenly disappearing.

Pyes and Jays in flocks, and very noisy.

The Raven or Hooded-Crow crying in the morning, with an interruption in their notes; or Crows being very clamorous at even.

The Heron, Bittern, and Swallow flying low.

Birds

Birds forsaking their meat, and flying to their nests.

Poultry going early to roost, or Pigeons to their dove-house.

Tame Fowls grubbing in the dust, and clapping their wings.

Small Birds seeming to duck, and wash in the sand.

The late and early crowing of the Cock, and clapping his wings.

The early singing of Wood-larks.

The early chirping of Sparrows.

The early note of the Chaffinch, near houses.

The dull appearance of Robin Red-breast, near houses.

Peacocks and Owls unusually clamorous.

SIGNS of WIND *from* BIRDS.

Sea and fresh water fowls gathering in flocks to the banks, and there sporting, especially in the morning.

Wild Geese flying high, and in flocks, and directing their course eastward.

Coots restless and clamorous.

The Hoopoe loud in his note.

The King's-fisher taking to land.

Rooks darting or shooting in the air, or sporting on the banks of fresh waters.

And, lastly, the appearance of the Malefigie at sea, is a certain forerunner of violent winds, and (early in the morning) denotes horrible tempests at hand.

SIGNS

SIGNS of FAIR WEATHER from BIRDS.

Halcyons, Sea-ducks, &c. leaving the land,
and flocking to the sea.

Kites, Herons, Bitterns, and Swallows flying
high, and loud in their notes.

Lapwings restless and clamorous.

Sparrows, after sun-rise, restless and noisy.

Ravens, Hawks, and Kestrels (in the morn-
ing) loud in their notes.

Robin Red-breast mounted high, and loud
in his song.

Larks soaring high, and loud in their songs.

Owls hooting with an easy and clear note.

Bats appearing early in the evening.

SIGNS of RAIN from BEASTS.

Asses braying more frequently than usual.

Hogs playing, scattering their food, or car-
rying straw in their mouths.

Oxen snuffing the air, looking to the south,
while lying on their right sides, or licking their
hooves.

Cattle gasping for air at noon.

Calves running violently and gamboling.

Deer, Sheep, or Goats, leaping, fighting,
or pushing.

Cats washing their face and ears.

Dogs eagerly scraping up earth.

Foxes barking, or Wolves howling.

Moles throwing up earth more than usual.

Rats

Rats and Mice more restless than usual.
A grumbling noise in the belly of Hounds.

SIGNS of RAIN from INSECTS.

Worms crawling out of the earth in great abundance.

Spiders falling from their webs.

Flies dull and restless.

Ants hastening to their nests.

Bees hastening home, and keeping close in their hives.

Frogs and Toads drawing nigh to houses.

Frogs croaking from ditches.

Toads crying on eminences.

Gnats singing more than usual.

But, if Gnats play in the open air, or if Hornets, Wasps, and Glow-worms appear plentifully in the evening, or if Spiders webs are seen in the air, or on grass, or trees, these do all denote fair and warm weather at hand.

SIGNS of RAIN from the SUN.

Sun rising dim or waterish.

Rising red, with blackish beams mixed along with his rays.

Rising in a misty or muddy colour.

Rising red and turning blackish.

Setting under a thick cloud.

Setting with a red sky in the east.

N. B. Sudden rains never last long; but when the air grows thick by degrees, and the Sun, Moon, and Stars shine dimmer

mer and dimmer, then it is like to rain six hours usually.

SIGNS of WIND from the SUN:

Sun rising pale, and setting red, with an Iris.
Rising large in surface.

Rising with a red sky in the north.

Setting of a bloody colour.

Setting pale, with one or more dark circles,
or accompanied with red streaks.

Seeming concave or hollow.

Seeming divided, great storms.

Parhelia, or mock-suns, never appear, but are followed by tempests.

SIGNS of FAIR WEATHER from the SUN.

Sun rising clear, having set clear the night before.

Rising while the clouds about him are driving to the west.

Rising with an Iris around him, and that Iris wearing away equally on all sides, then expect fair and settled weather.

Rising clear, and not hot.

Setting in red clouds, according to the old observation,

The evening red, and morning grey,

Is the sure sign of a fair day.

SIGNS of RAIN from the MOON.

Moon pale in colour, rain.

D

Horns

Horns blunt at first rising, rain.

Horns blunt, at or within two or three days after change, denotes rain for that quarter.

An Iris with a south wind, rain next day.

Wind south third night after change, rain.

The wind south, and the Moon not seen before the fourth night, rain most of that month.

Full Moon in April, new and full Moon in August, for most part, bring rain.

Mock-moons are the forerunners of great rains, land-floods, and inundations.

SIGNS of WIND *from the Moon.*

Moon seeming greatly enlarged.

Appearing of a red colour.

Horns sharp and blackish.

If included with a clear and ruddy Iris.

If the Iris be double, or seem to be broken in parts, tempests.

N. B. On the new Moon, the wind, for most part, changes.

When the Moon, at four days old, has her horns sharp, she foretells a tempest at sea, unless she has a circle about her, and that too entire ; because, by that, she shews that it is not like to be bad weather till it is full Moon.

SIGNS of FAIR WEATHER *from the Moon.*

Moon seeming to exhibit bright spots.

A clear Iris with full Moon.

Horns sharp fourth day, fair till full.

Horns

Horns blunt at first rising, at or within two or three days after change, denotes rain for that quarter, but fair the other three quarters.

Moon clear three days after change, or before full, always denotes fair weather.

After every change and full, rain, for the most part, succeeded by fair settled weather.

Moon clear and bright, always fair weather.

SIGNS of the WEATHER from the STARS.

Stars seeming large, dull, and pale of colour, rain; or, when their twinkling is not perceptible; or, if encompassed with an Iris.

In summer, when wind is at east, and stars seem greater than usual, then expect sudden rain.

Stars appearing great in number, yet clear and bright, seeming to shoot or dart, denote fair weather in summer, and in winter frost.

SIGNS of RAIN from the CLOUDS.

In cloudy weather, when the wind falls, rain follows.

Clouds growing bigger, or seeming like rocks or towers. Settling on mountains tops.

Coming from the south, or often changing their course.

Many in number at north-west in the even.

Being black in colour from the east, rain at night; but out of the west, rain next day.

Being many, like fleeces of wool from the east, rain for two or three days.

Lying like ridges about mid-day in the south west, shew great storms both of wind and rain to be nigh.

SIGNS of WIND *from the CLOUDS.*

Clouds flying to and fro.

Appearing suddenly from the south or west.

Appearing red, or accompanied with redness in the air, especially in the morning.

Being of a leadish colour in the north-west.

Single clouds denote wind from whence they come.

But if at sun-set clouds appear with golden edges, or diminish in bulk, or small clouds sink low, or draw against the wind, or appear small, white, and scattered in the north-west, (such as are vulgarly called *Mackarel*) when the Sun is high; these are signs of fair weather.

N. B. It is often observed, that, though the *Mackarel* sky denotes fair-weather for that day; yet, for most part, rain follows in a day or two after.

SIGNS of RAIN *from the RAIN-BOW.*

After a long drought, the Rain-bow denotes sudden and heavy rains.

If green be the predominant colour, it denotes rain; but if red, wind with rain.

If the colours grow darker, rain.

If the Bow seems broken, violent storms.

If appearing at noon, much rain.

If in the west, great rain, with thunder.
N. B. It is observed, that, if the last week in February, and the first fortnight of March, be mostly rainy, and attended with frequent appearances of the Bow, a wet spring and summer may be expected.

SIGNS of FAIR WEATHER from the RAIN-BOW.

The Rain-bow appearing after long rains, denotes fair weather at hand.

If the colours grow lighter, fair.

If the Bow suddenly disappear, fair.

If the Bow appear in the morning, it is the sign of small rains, followed by fair weather.

If appearing at night, fair weather.

If appearing in the east in the evening, fair.

If the Bow appear double, it denotes fair weather at present, but rain in a few days.

If in autumn it continue fair for two days after the appearance of the Aurora Borealis, expect fair weather for at least eight days more.

SIGNS of RAIN from MISTS.

If Mists be attracted to the tops of hills, then expect rain in a day or two.

If, in dry weather, they be observed to ascend more than usual, then expect sudden rain.

Mists in the new Moon always forshew rain in the old.

Mists also in the old Moon denote rains to happen in the new.

A misty white scare, in a clear sky, in the south-east, is always a forerunner of rain.

SIGNS of FAIR WEATHER from MISTS.

If Mists dissipate quickly, or descend after rain, it is a sure sign of fair weather.

A general Mist, before sun-rising near the full Moon, denotes fair weather for about a fortnight running.

If, after sun-set, or before sun-rise, a white Mist arise from the waters and meads, it denotes warm and fair weather next day.

A misty dew on the inside of glass windows shews fair weather for that day.

SIGNS of RAIN from INANIMATE BODIES.

Wood swelling, or stones seeming to sweat.

Lute or viol strings breaking.

Primed canvasses or pasted maps relaxing.

Salt becoming moist.

Rivers sinking, or floods suddenly abating.

Remarkable sparkling of lamps or candles.

Remarkable halo about the candle.

Great dryness of the earth.

Pools seeming troubled or muddy.

Yellow scum on the surface of stagnant waters.

Dandelion or pimpernel shutting up.

Trefoil swelling in stalk, while the leaves bow down.

N. B. A dry spring is always attended with a rainy winter.

SIGNS

SIGNS of WIND from INANIMATE BODIES.

Winds shifting to the opposite point.

Sea calm, with a murmuring noise.

A murmuring noise from the woods and rocks, when the air is calm.

Leaves and feathers seeming much agitated.

Tides high, when the thermometer is high.

Trembling or flexuous burning of flames.

Coal burning white with a murmuring noise.

Thunder in the morning with a clear sky.

Thunder from the north.

N. B. Whenever the wind begins to shift, it will not rest till it comes to the opposite point; and, if the wind be in the north, it will be cold; if in the north-east, colder; if in the south, it brings rain; but, if in the south-west, more rain.

SIGNS of RAIN CEASING.

The sudden closing of gaps in the earth.

The remarkable rising of springs or rivers.

If the rain begins an hour or two before sun-rise, it is like to be fair ere noon; but, if an hour or two after sun-rise, it, for most part, happens to continue all day, and then to cease.

When it begins to rain from the south, with a high wind for two or three hours, and that the wind falls, and it still continues raining, it is then like to continue for twelve hours or more, and then to cease.

N. B. These long rains seldom happen to hold above twenty-four hours, or happen above once a-year.

SIGNS of WIND CEASING.

A hasty shower after raging winds is a sure sign of the storm being near an end.

If the water ruckles, and frequent bubbles arise; or if the Halcyon or King's-fisher attempt the sea while the storm lasts; or Moles come out of their holes; or Sparrows chirp merrily; these are all certain signs of the storm's ceasing.

Both sea and fresh water fishes, by their frequent rising and fluttering on the surface of the water, foretell the storm nigh over; but especially Dolphins spurting up water in a storm, foretell a calm.

N. B. Let the wind be in what quarter it will, upon the new Moon, it presently changes.

SIGNS of HAIL.

Clouds white, inclining to yellow, and moving heavily, though the wind be high, is a sure sign of hail.

If the eastern sky, before sun-rise, be pale, and refracted rays appear in thick clouds, then expect great storms of hail.

White clouds in summer are a sign of hail; but in winter they denote snow, especially when we perceive the air to be a little warm.

In spring or winter, when clouds appear of a blueish white, and expand much, expect small hail or drizzling, which properly is no other than frozen mists.

SIGNS

SIGNS of THUNDER.

Meteors shooting in the summer's evening, or chops and clefts in the earth, when the weather is sultry, always foretell thunder nigh.

In summer or harvest, when the wind has been south two or three days, and the thermometer high, and clouds rise with great white tops like towers, as if one were upon the top of another, and joined with black on the nether side, expect rain and thunder suddenly.

If two such clouds arise, one on either hand, it is then time to look for shelter, as the thunder is very nigh.

N. B. It is observed, that it thunders most with a south wind, and least with an east.

SIGNS of COLD and FROSTY WEATHER.

Sea-pyes, Starlings, Fieldfares, with other migratory birds appearing early, denote a cold season to ensue.

The early appearance of small birds in flocks, and of Robin Red-breast near houses.

Sun, in harvest, often setting in a mist, or broader than usual.

Moon bright, with sharp horns, after change.

Wind shifting to the east or north after change.

Sky full of twinkling stars.

Small clouds hovering low in the north.

Snow falling small, while clouds appear on heaps like rocks.

N. B.

N. B. Frosts in autumn are always succeeded with rain.

SIGNS of THAW.

Snow falling in large flakes, while the wind is at south. Cracks appearing in the ice.

Sun looking waterish.

The Moon's horns blunted.

Stars looking dull.

Wind turning to the south.

Wind extremely shifting.

It is also observed, that, if October and November be frost and snow, January and February are like to be open and mild.

SIGNS of DROUGHT.

Fair weather, for a week together, while the wind is all that time in the south, is, for most part, followed by a great drought.

If February be, for most, rainy, spring and summer quarters are like to be so too; but, if it happen to be altogether fair, then expect a drought to follow.

If lightening follow after twenty-four hours of dry and fair weather, drought will follow; but if within the 24 hours, expect great rains.

SIGNS of HARD WINTERS.

A moist and cold summer and mild autumn, are sure signs of a hard and severe winter.

Store

Store of hops and haws denote the same.

The hazel-tree flowering is ever observed to foretell the same.

Acorns found without any insect, is a sure prognostic of a very hard winter.

SIGNS of PESTILENTIAL SEASONS.

A dry and cold winter, with a southerly wind.

A very rainy spring, sickness in summer.

If summer be dry with the wind northerly, but the autumn rainy and the wind southerly, great sickness is likely to follow.

Great heats in spring time without winds.

Roots having a luscious taste, while the wind has been long southerly without rain.

And, lastly, great quantities of stinking atoms, insects or animals, as flies, frogs, snakes, locusts, &c.

EXPERIMENTS of the LEECH WORM.

Inclose the Leech Worm in an eight ounce vial glass, three fourths filled with water, covered with a bit of linen; let the water be changed once a week in summer, and once a fortnight in winter.

If the Leech lies motionless at the bottom in a spiral form, fair weather.

If crept to the top, rain.

If restless, wind.

If very restless, and without the water, thunder.

If,

If, in winter, at bottom, frost.

But if, in the winter, it pitches its dwelling
on the mouth of the vial, snow.

SIGNS of WEATHER from the BAROMETER.

In calm weather, when the air is inclined to
rain, the Mercury is low.

But, when tending to fair, it will rise.

In very hot weather, when falling, it fore-
shews thunder.

If rising in winter, frost; but, if falling in
frost, thaw.

If rising in a continued frost, snow.

If foul weather quickly on its falling, soon
over.

If fair weather quickly on its rising, soon
over also.

If rising high in foul weather, and so conti-
nuing for two or three days, before the foul
weather is over, then expect a continuance of
fair weather.

But if in fair weather the Mercury fall low,
and so continue for two or three days, then
expect much rain, and probably high winds.

N. B. In an east wind, the Mercury always
rises, and falls lowest before great winds.

F I N I S.

Entered in Stationers Hall.